CLAIMS

1. A method of fabricating a composite structure, the method comprising:

partially embedding a bond enhancement element into a ceramic matrix composite material; and

applying a ceramic coating to the ceramic matrix composite material over that portion of the bond enhancement element not embedded in the ceramic matrix composite material.

2. The method of claim 1, further comprising forming an opening in the ceramic matrix composite material to receive the bond enhancement element.

3. The method of claim 1, further comprising forming an opening in the ceramic matrix composite material when the ceramic matrix composite material is in a bisque fired stage.

4. The method of claim 1, further comprising inserting the bond enhancement element into the ceramic matrix composite material when the ceramic matrix composite material is in a wet prepreg stage.

5. The method of claim 1, further comprising co-firing the ceramic matrix composite material and the ceramic thermal insulation material to interlock the bond enhancement element there between.

6. The method of claim 1, further comprising inserting the bond enhancement element into the ceramic matrix composite material when the ceramic matrix composite material is in a dry perform stage prior to infiltration of matrix material.

7. The method of claim 1, further comprising:

embedding a bond enhancement element into a compressible material; and

compressing the compressible material between a tool and the ceramic matrix composite material to drive the bond enhancement element partially into the ceramic matrix composite material.

8. The method of claim 1, further comprising:

forming a tool comprising a fugitive material having particles of a bond enhancement material partially embedded on a surface of the tool;

applying a force between the tool surface and a surface of the ceramic matrix composite material to partially embed the particles of bond enhancement material into the surface of the ceramic matrix composite material; and

applying heat to at least partially cure the ceramic matrix composite material and to remove the fugitive material, exposing that portion of the particles of bond enhancement material not partially embedded in the surface of the ceramic matrix composite material.

9. The method of claim 1, further comprising:

partially embedding a layer of particles of a bond enhancement material into a surface of a layer of a mold release material; and

applying a force between the surface of the mold release material and a surface of the ceramic matrix composite material to partially embed the particles of bond enhancement material into the surface of the ceramic matrix composite material.

10. The method of claim 1, further comprising:

forming a lower tool comprising an opening extending through a thickness of the lower tool from a pressure surface to a work piece surface;

forming an upper tool comprising a drive element extending from a pressure surface, the drive element sized to fit into the lower tool opening;

inserting the bond enhancement element into the lower tool opening;

applying the lower tool work piece surface to a surface of the ceramic matrix composite material;

aligning the upper tool and the lower tool so that the drive element extends into the lower tool opening; and

urging the upper tool against the lower tool to drive the bond enhancement element partially into the ceramic matrix composite material.

11. The method of claim 10, further comprising selecting a length dimension of the drive element extending from the upper tool pressure surface so that the bond enhancement element is only partially embedded into the ceramic matrix composite material when the pressure surface of the upper tool contacts the pressure surface of the lower tool.

12. The method of claim 10, further comprising forming the opening in the lower tool to comprise an upper portion comprising a first width dimension proximate the pressure surface and a lower portion comprising a second width dimension smaller than the first width dimension proximate the work piece surface; and

forming the drive element to have a width dimension between the first width dimension and the second width dimension so that the drive element will bottom out in the upper portion during the step of urging the upper tool against the lower tool.

13. The method of claim 10, further comprising:

removing the upper tool and the lower tool to expose the bond enhancement element partially embedded into the surface of the ceramic matrix composite material; and

applying a ceramic thermal insulation material over the surface of the ceramic matrix composite material to embed that portion of the bond enhancement element not embedded into the ceramic matrix composite material.

14. A product formed by the process of claim 1.

15. The product of claim 14, wherein the bond enhancement element comprises a monolayer of particles.

16. The product of claim 15, wherein the ceramic thermal insulation material comprises a plurality of spheres having an average diameter, and wherein the bond enhancement member comprises a monolayer of particles having an average diameter less than the average diameter of the spheres in the ceramic thermal insulation material.

17. The product of claim 14, wherein the bond enhancement element comprises a rod-shaped structure.

18. The product of claim 17, wherein the rod-shaped structure comprises a fiber bundle.

19. The product of claim 14, wherein the thermal insulation material comprises an outside surface defining an airfoil shape and the ceramic matrix composite material comprises an inside surface defining a core region, and further comprising:

the bond enhancement element extending completely through a thickness of the ceramic matrix composite material to have a portion extending into the core region; and

a core material disposed within the core region and embedding the portion of the bond enhancement member extending into the core region.

20. A method of fabricating a composite structure, the method comprising:

forming a ceramic insulation material having a bond enhancement member partially embedded within and partially extending beyond a surface of the ceramic insulation material; and

using the surface of the ceramic insulation material as a mold for forming a ceramic matrix composite material to embed the portion of the bond enhancement member that extends beyond the surface of the ceramic insulation material.

21. The method of claim 20, further comprising:

forming a mold of a fugitive material having particles of a bond enhancement material partially embedded in a surface; and

using the mold to form the ceramic insulation material to have the bond enhancement particles partially embedded therein.

22. A method of fabricating a composite structure comprising:

forming a ceramic matrix composite substrate by laying up a plurality of layers of ceramic fibers and infusing a ceramic matrix material into the fiber layers;

forming a plurality of bond enhancement elements as waves on a top surface of the ceramic matrix composite substrate by inserting solid shapes between layers of the ceramic matrix composite substrate; and

forming a ceramic coating on the top surface of the ceramic matrix composite substrate to mechanically engage the bond enhancement elements.

23. The method of claim 22, further comprising forming the solid shapes of a fugitive material.

24. The method of claim 22, further comprising:

forming the ceramic coating to comprises a plurality of ceramic spheres; and

forming the bond enhancement elements so that a distance between a top and a bottom of the waves is at least one half an average diameter of the spheres.